*भारतीय मानक*
*Indian Standard*

**IS 4469 : 2020**

# फ्लू-क्यूरिंग तंबाकू बार्न के निर्माण की रीति संहिता

*( दूसरा पुनरीक्षण )*

# Code of Practice for Construction of Flue-Curing Tobacco Barns

*( Second Revision )*

ICS 65.160



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Tobacco and Tobacco Products Sectional Committee, FAD 04

## FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Tobacco and Tobacco Products Sectional Committee had been approved by the Food and Agriculture Division Council.

Curing of tobacco in a flue-curing barn is an important post-harvest production practice of flue-cured tobacco and plays a vital role in determining the quality of the finished product.

This Indian Standard was first published in 1967 and subsequently revised in 1985. The second revision of this standard is prompted by new developments, such as improved barn design, insulation of barns, better ventilation system, etc. All these measures have led to significant fuel saving, reduction in curing time and overall improvement in the quality of flue-cured tobacco.

For the purpose of deciding whether a particular requirement of this standard is complied with the final value, observed or calculated, expressing the result of a test or analysis shall be rounded off in accordance with IS 2 : 1960 ‘Rules for rounding off numerical values (*revised*)’. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# CODE OF PRACTICE FOR CONSTRUCTION OF FLUE-CURING TOBACCO BARNS

*( Second Revision )*

## 1 SCOPE

**1.1** This standard specifies structural designs, materials of construction, construction guidance and other related requirements of flue-curing tobacco barns.

**1.2** This standard does not cover details regarding the furnaces to be used in the barns.

## 2 REFERENCES

The standards given below contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent of the standard.

| *IS No.* | *Title* |
|---|---|
| 10335 : 2016 | Glossary of terms of tobacco and tobacco products (*third revision*) |
| 654 : 1992 | Clay roofing tiles, mangalore pattern — Specification *(third revision*) |
| 277 : 2018 | Galvanized steel strips and sheets (plain and corrugated) — Specification (*seventh revision*) |

## 3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 10335 in addition to the following shall apply.

**3.1 Curing** — A process of promoting desired visual, physical and chemical changes by controlled drying of tobacco leaves after harvesting. Freshly harvested tobacco leaf contains about 80 percent moisture which makes it unfit for storing and also for any form of consumption. Hence, all tobaccos need to be cured. During curing, the leaf not only loses moisture but also undergoes complex physical and chemical changes. These changes can be controlled by maintaining a scheduled regime of temperature and humidity at each stage of curing. A number of different types of curing are practiced depending upon the type of tobacco to be cured (*see* IS 10335). It is only the flue-cured type of tobacco that requires a flue-curing barn where temperature and humidity are controlled during the entire curing process spread over 7 days or less.

**3.2 Curometer** — It is a type of hygrometer which has been renamed as curometer specially for the Indian flue-cured tobacco grower to relate to the device and its application in curing. The temperature readings of the dry-bulb and wet-bulb thermometers in the device determine the relative humidity (RH percent) in the barn. Usually, a ready table is available to read RH percent directly from the temperature readings which prompt the adjustment of the ventilators as well as stoking of the furnace to maintain required temperature and humidity in the barn.

**3.3 Flue-curing** — Flue-curing of tobacco is a three-stage process spread over 6 - 7 days, the stages being, yellowing and colour fixing, lamina drying, and stem drying. Each curing stage has its own distinct RH and temperature requirements which need to be maintained and monitored during the entire curing process. These conditions can only be regulated in a flue-curing barn (*see* IS 10335).

**3.4 Relative Humidity (RH Percent)** — The amount of water vapour present in the air expressed as a percentage of the amount needed for saturation at the same temperature. RH in a flue-curing barn is determined with the help of a curometer (*see* **3.2**).

**3.5 Turbo Ventilator** — A wind-powered device that exhausts hot and stale air from the working space of enclosed structures without the use of electricity. These are installed on the roof. Turbine ventilators are round and have vanes. As the wind hits the turbo ventilator, vanes start rotating, causing exhaustion of hot air with simultaneous drawing of fresh air into the barn and creating continuous ventilation.

Since continuous ventilation is not required in a flue-curing barn, a special flaps assembly is pre-fitted in the throat of the turbo ventilator to control the ventilation. The turbo ventilator augments the ventilation provided by the traditional shutter-type top ventilator and bottom ventilators which are essential features of any flue-curing barn. Due to improved ventilation, the curing time is shortened by as much as 16-18 h resulting in substantial fuel saving.

## 4 DESCRIPTIONS

Flue-curing barn is a masonry structure having a gabled roof. The barn is equipped with a furnace, a flue pipe arrangement spread over the floor of the barn, a chimney, bottom ventilators at the plinth level, shutter-type ventilator and turbo ventilator on the roof top, a curometer and a curometer window for monitoring temperature and humidity, tiers for hanging tobacco leaves for curing and a leaf observation window for monitoring the progress of curing. The flue pipe arrangement distributes the heat evenly over the floor of the barn. The heat travels upwards heating the barn evenly, dries and cures the tobacco leaves under controlled conditions of temperature and humidity. All essential features of the two types of flue-curing barns are shown in the floor plans (Fig. 1 and Fig. 2) and in various other figures (Fig. 3 to Fig. 4). In addition, the barns also have other ancillary structures to support the operation of the barn, for example, fuel storage, space for stringing the freshly harvested leaf and for storing cured leaf, etc.

## 5 REQUIREMENTS

Flue-curing barns shall comply with the following requirements.

### 5.1 Barn Location

**5.1.1** The barn shall be located on a raised and well drained site, not liable to flooding and inundation.

**5.1.2** The barn shall be located at a place operationally convenient to the farmer.

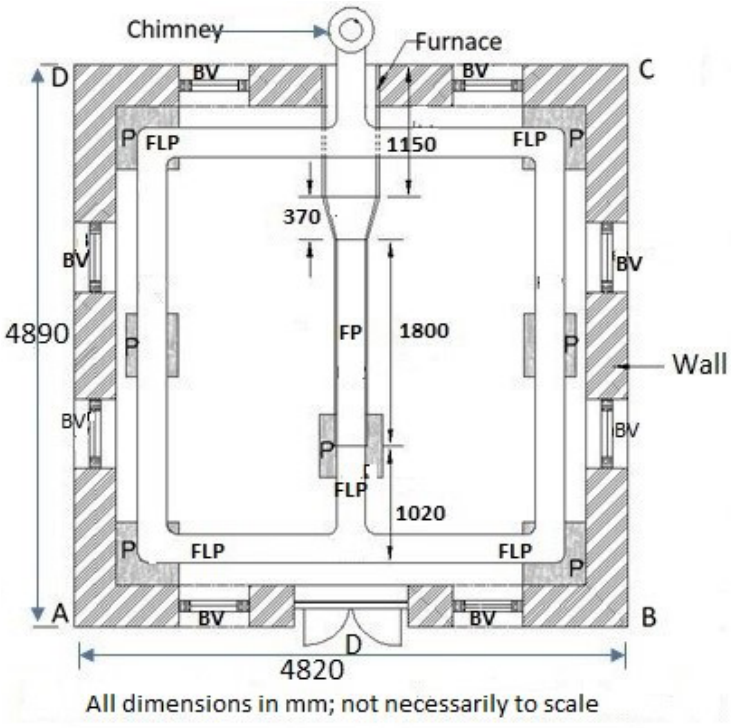
**5.1.3** The location of the ancillary structures in relation to the barn shall be, such as to serve as good wind breakers.

### 5.2 Barn Types

**5.2.1** There shall be two types of barns:

a) *Type A* — Having Mangalore tiled roof, popular in Karnataka (*see* Fig. 3 and Fig. 5); and

b) *Type B* — Having corrugated galvanized iron (CGI) roof, popular in Andhra Pradesh and Telangana (*see* Fig. 4 and Fig. 6).




| Abbreviation | Description |
|---|---|
| BV | Bottom Ventilator |
| D | Door |
| FP | Furnace Pipe |
| FLP | Flue Pipe |
| P | Pedestal |

FIG. 1 FLOOR PLAN — BARN TYPE A

**5.2.2** The two barn types A and B are visibly differentiable by their appearance and construction, specially by their sloping roofs. Type A barn roof is tiled with the typical red Mangalore tiles and has very steep slope. Type B barn roof is fabricated with CGI sheets and is less steep than type A barn roof.

As all internal essential features pertaining to flue-curing process remain identical in both barn types, the curing of tobacco in the two barn types will yield similar results. Hence, the type of barn to be erected is left to the choice of the farmer.

### 5.3 Barn Dimensions

The outer dimensions of the two types of barns shall be as follows (l × w × h): height (h) up to the gable end.

a) Type A: 4.82 × 4.89 × 6.78 m (height at eave end 5.0 m) (Fig. 3).
b) Type B: 5.81 × 5.81 × 6.50 m (height at eave end 5.25 m) (Fig. 4).

NOTES:

**1** These barn dimensions are given here for illustration. The barn shape and size can vary and will be decided by the farmer based on the crop size and reaping pattern.

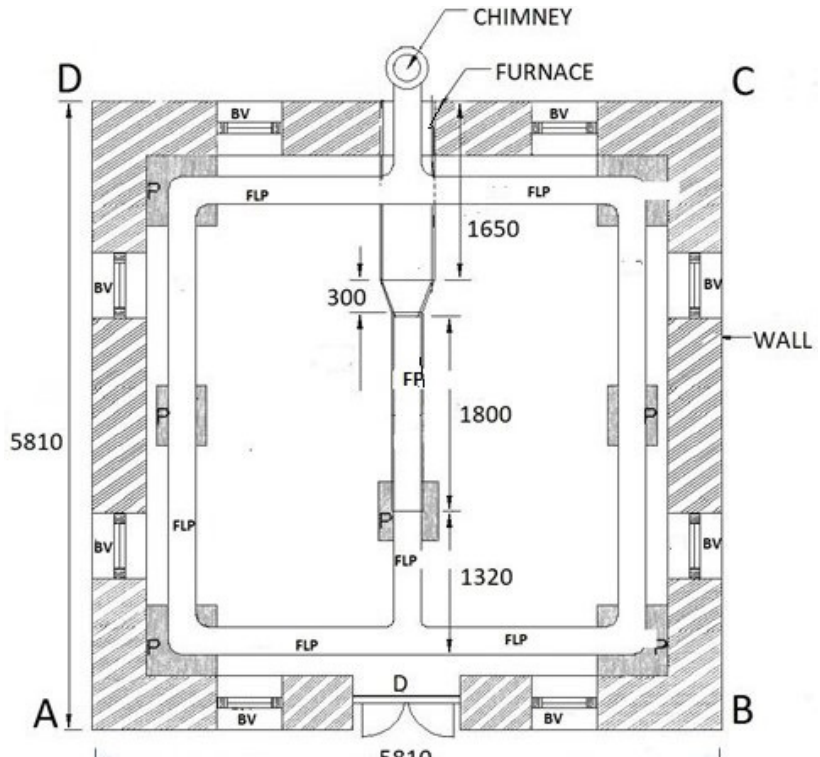
**2** Leaf size determines the distance between vertical tiers and overall height of the barn.

### 5.4 Foundation

**5.4.1** The depth of the foundation of the barn shall depend up on the soil type and the region where the barn is located.

**5.4.2** Foundation should be at least 1.14 m deep for type A barn and 1.36 m deep for type B barn. The earth work excavation shall be marked correct to the dimensions depending on the type of the barn so that the final measurements after excavation are as follows:

a) Type A barn: 1.14 × 0.76 m; and
b) Type B barn: 1.36 × 0.99 m.




| Abbreviation | Description |
|---|---|
| BV | Bottom Ventilator |
| D | Door |
| FP | Furnace Pipe |
| FLP | Flue Pipe |
| P | Pedestal |

FIG. 2 FLOOR PLAN — BARN TYPE B

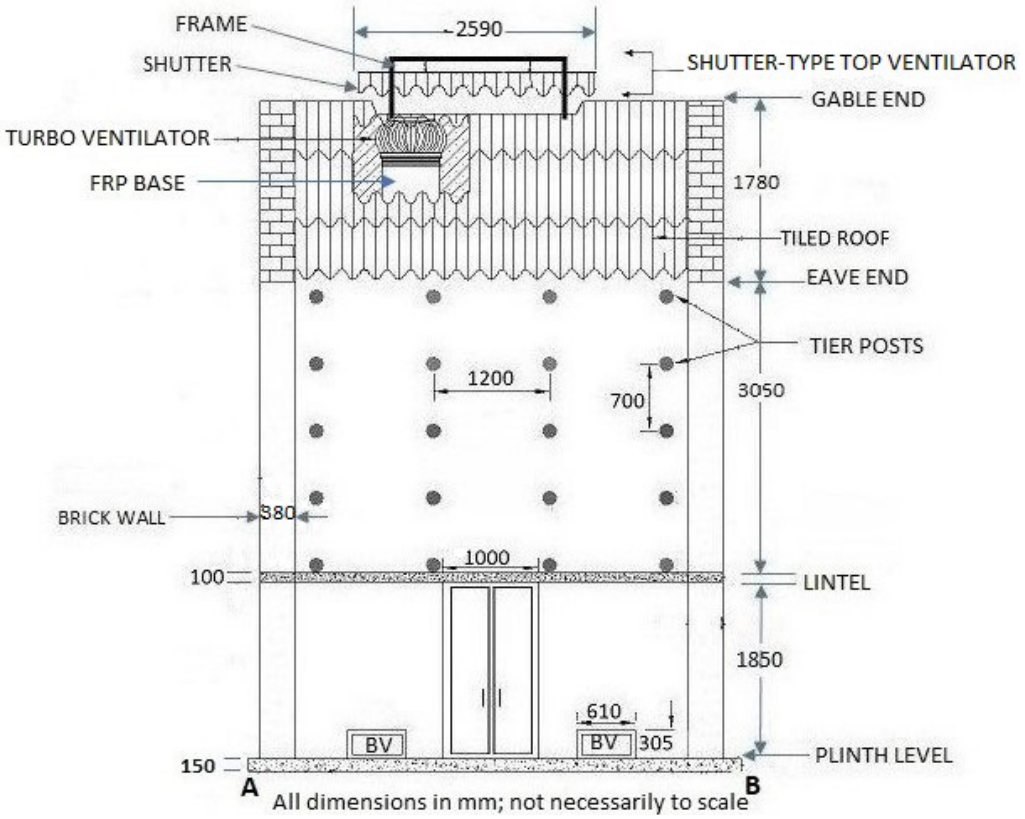



FIG. 3 FRONT ELEVATION SIDE AB — BARN TYPE A

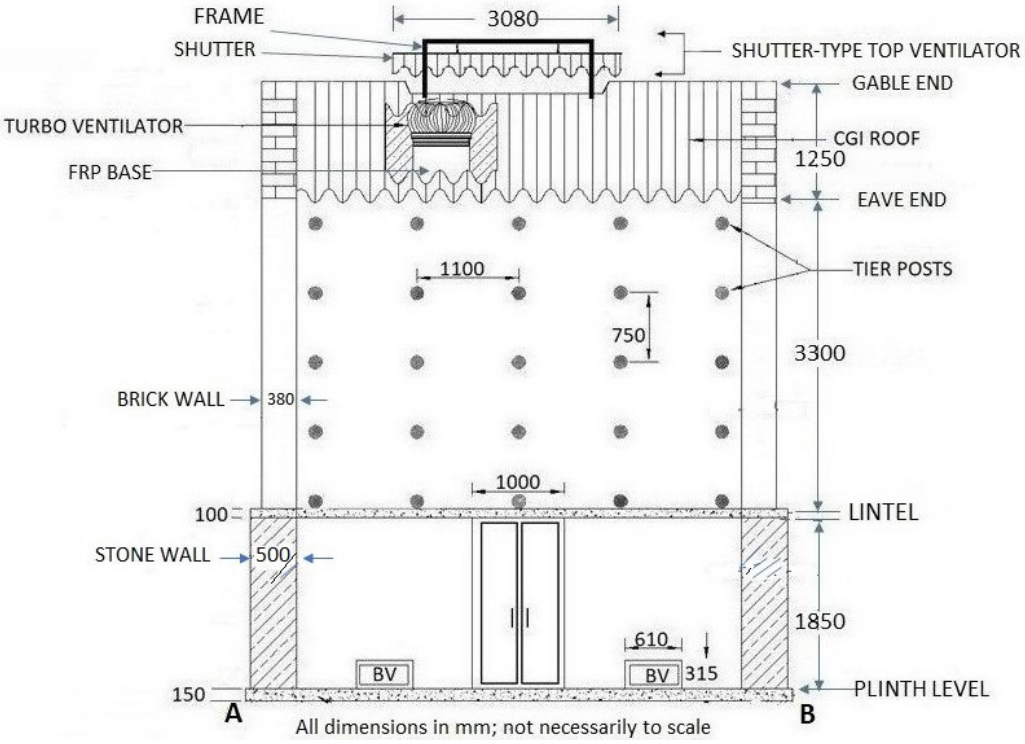



FIG. 4 FRONT ELEVATION SIDE AB — BARN TYPE B

### 5.5 Basement

**5.5.1** *Basement of Type A Barn*

A 0.23 m thick bed of concrete (1:4:8) shall be laid, well rammed and cured at least for 3 days before commencement of further work. Basement construction shall be carried out with sized stones using cement mortar (1:6) up to the ground level, maintaining a width of 0.61 m. The basement, above the ground level, shall be 0.53 m wide and 0.60 m high and shall be constructed with sized stones using cement mortar (1:6) with cement mortar pointing on both sides. The trenches are then filled up with earth and packed.

**5.5.2** *Basement of Type B Barn*

Packing of the trenches with boulder stones up to a height of 0.46 m with 50 percent gravel shall be done followed by watering and ramming. Next, a 0.30 m thick layer of cement concrete (1:5:10) shall be laid, the layer is well rammed and cured for at least 3 days. This is followed by constructing a 0.66 m wide footing with burnt bricks using cement mortar (1:6) up to the ground level. The basement, above the ground level, shall be 0.66 m wide and 0.60 m high and shall be constructed with burnt bricks using cement mortar (1:6) with cement mortar pointing on both sides. The trenches are then filled up with earth and packed.

### 5.6 Plinth Slab and Lintels

**5.6.1** A RCC (1:4:4) slab (0.15 m thick) shall be provided at the plinth level in both barns.

**5.6.2** A RCC (1:4:4) band 0.10 m thick shall also be provided at the lintel level to increase the stability of the structure (Fig. 3 and Fig. 4). The RCC lintels over windows, door and ventilators shall be provided as required.

### 5.7 Floor

The floor of both the types of barns shall be kutcha or mud flooring with earth filling up to the required level.

### 5.8 Walls

**5.8.1** *Walls of Type A Barn*

Walls of 0.38 m thickness are to be constructed with burnt bricks using cement mortar up to a height of 5.0 m at the eave ends and 6.78 m at the gable ends. Openings shall be provided in the two eave-end walls at assigned heights for inserting the wooden tier posts. A RCC band (0.1 m thick) shall be provided at the lintel level (Fig. 3 and Fig. 5). The walls are plastered inside with earth mortar and outside with cement mortar (1:6).

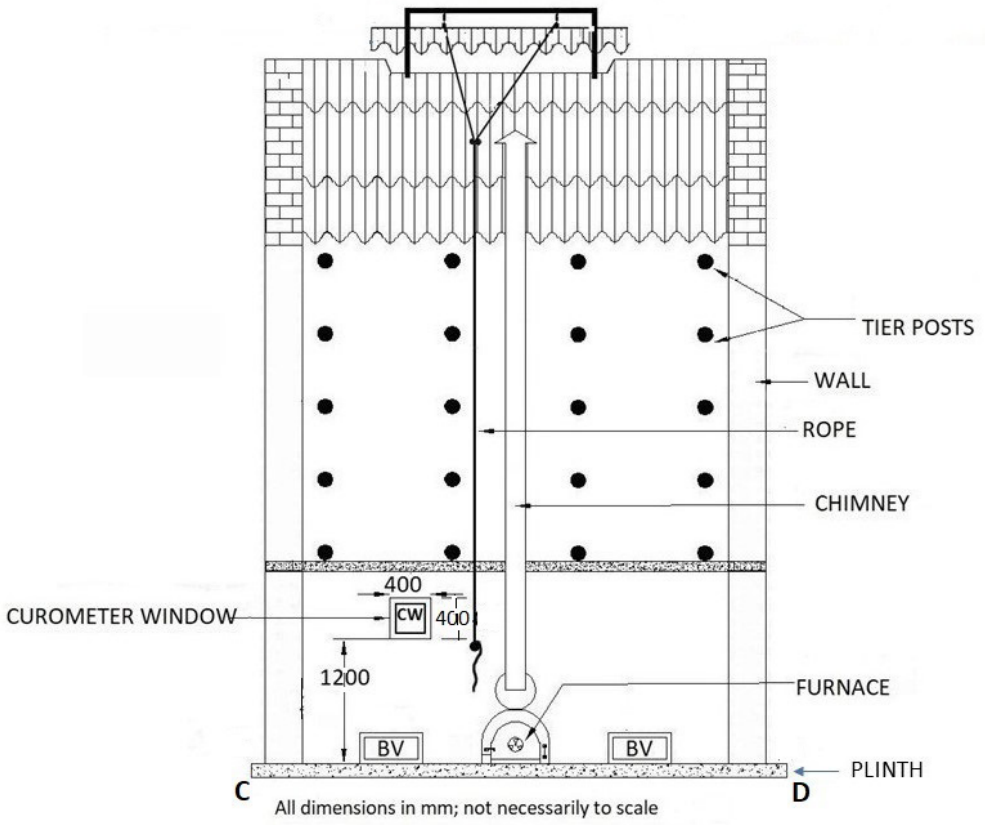



FIG. 5 ELEVATION SIDE CD — BARN TYPE A

**5.8.2** *Walls of Type B Barn*

Walls (0.50 m thick) shall be constructed with sized stones up to a height of 1.85 m and thereafter 0.38 m thick with burnt bricks using cement mortar (1:6) up to a height of 5.25 m at the eave ends and 6.50 m at the gable ends. Openings shall be provided in the two eave -end walls at assigned heights for inserting the wooden tier posts. A RCC band (10 cm thick) shall be provided at the lintel level (Fig. 4 and Fig. 6). The walls are plastered inside with earth mortar and outside with cement mortar (1:6).

**5.9 Barn Roof**

Flue-curing barns have gabled roofs, the slope in the roof prevents water stagnation and leakage in the barn and also facilitates air movement inside the barn. Type A barn roofs are tiled with Mangalore tiles (as per IS 654) while Type B barn roofs are fabricated with 0.55 mm thick (25 gauge) CGI sheet (*as per* IS 277).

Provision shall be made for appropriate openings in the middle of the roof ridge and in the roof on the side opposite that of the chimney for fitting the roof-top shutter-type and turbo ventilators.

**5.9.1** *Barn Roof of Type A Barn*

The roof is laid with Mangalore tiles which are pointed with cement lime mortar composite mixture. Roof frame, for supporting and laying the tiles, is to be made of wooden collar trusses, wall plates, rafters, purlins, etc in the usual way. The roof slope shall be at least 33° preferably 45°. The eaves shall be a minimum 30 cm wide, to throw rain water clear of the walls.

**5.9.2** *Barn Roof of Type B Barn*

The roof is fabricated with CGI sheet 0.55 mm thick (25 gauge). The roof frame, for supporting and fixing CGI sheet, will be made of country wood collar trusses, rafters, wall plates, purlins, etc, in the usual way. The roof shall have a slope preferably 15°. The eaves should be minimum 30 cm wide to throw rain water clear of the walls.

**5.9.3** *Insulation of Barn Roofs*

Insulation shall be carried out in the plane of the roof pitch, that is, immediately below the sloping roof by lining the roof from inside with a minimum 100 mm thick glass wool padding (minimum density 12 kg/m$^3$) held in place by galvanized iron (GI) sheet 0.40 mm thick (28 gauge) along the length of rafters (Fig. 7 and Fig. 8). GI sheet also ensures fool-proof safety in terms of fire hazard and contamination. The method prescribed here is suitable for both types of barns.

NOTE — Paddy straw may be used in place of glass wool.

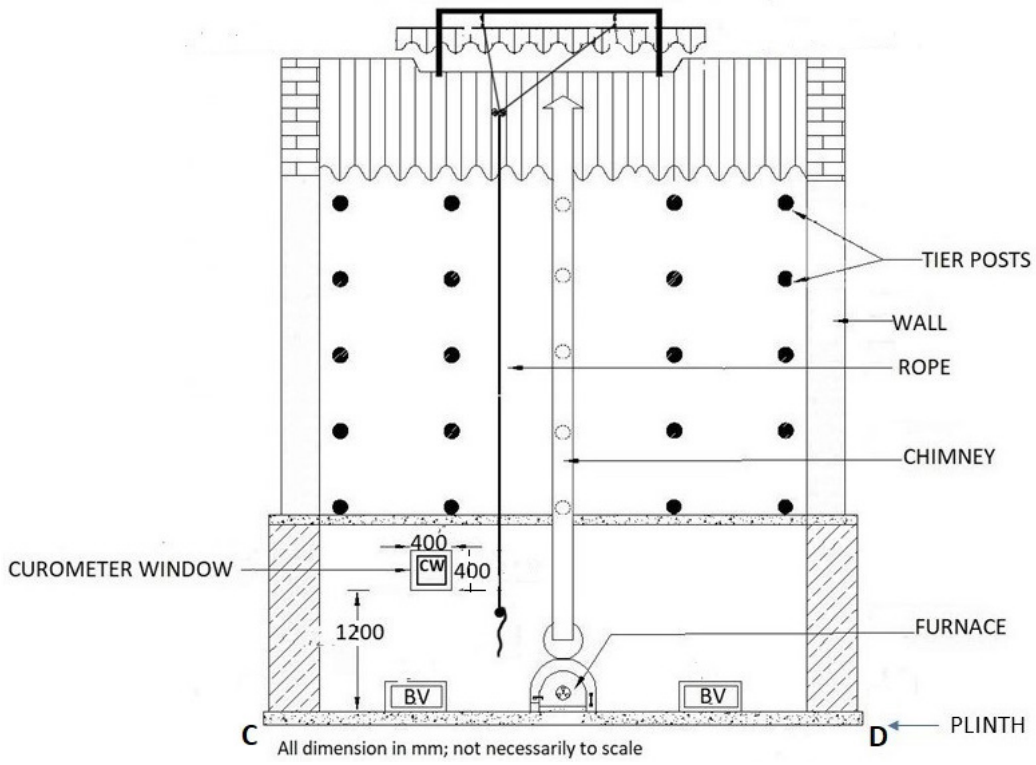



FIG. 6 ELEVATION SIDE CD — BARN TYPE B

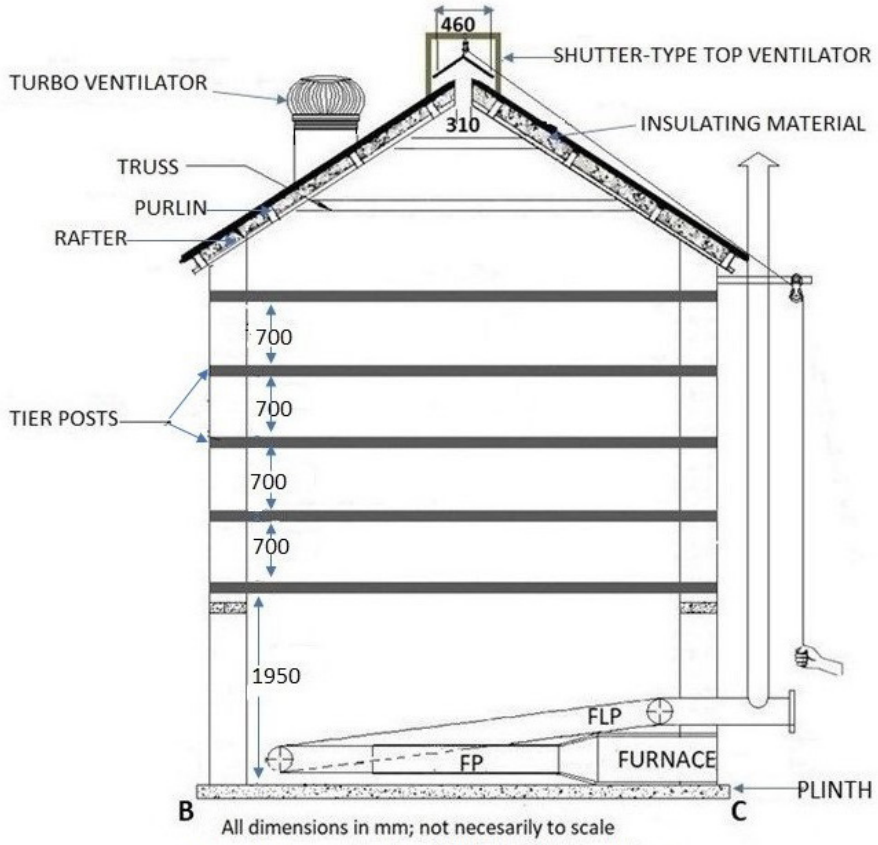



FIG. 7 CROSS-SECTION SIDE BC — BARN TYPE A

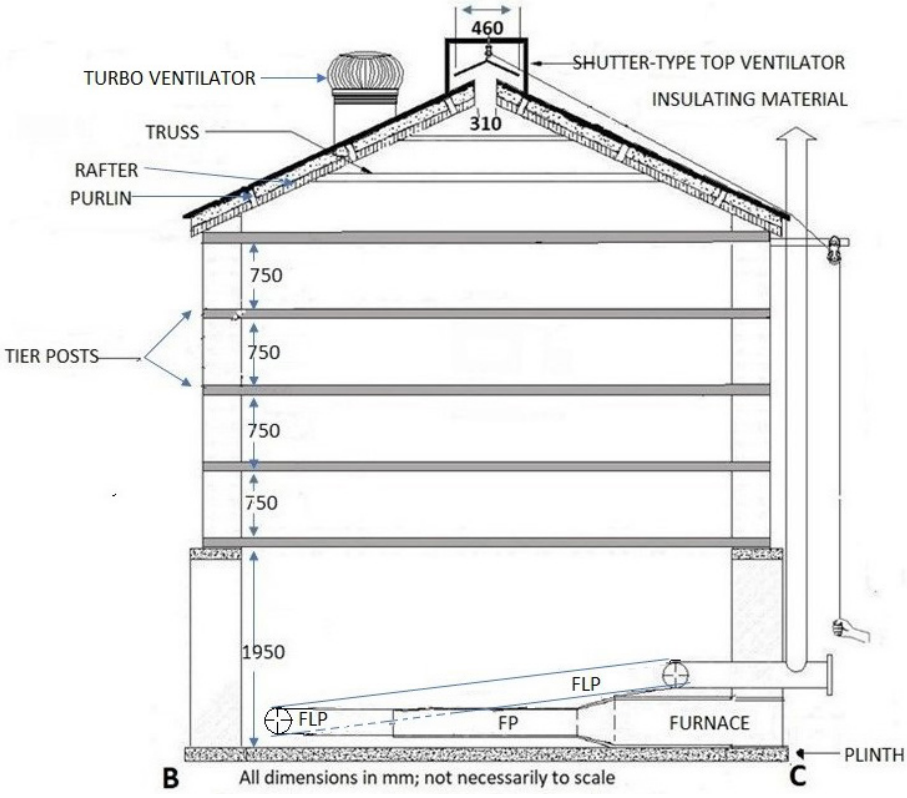



FIG. 8 CROSS-SECTION SIDE BC — BARN TYPE B

**5.9.3.1** GI sheet 0.40 mm thick (28 gauge) is cut to required size. The GI piece is firmly fastened to the wooden rafter by using 2.5 cm nails, leaving one side open for stuffing glass wool.

**5.9.3.2** The 100 mm glass wool padding (**5.9.3.1**) is then stuffed into the space between the roof and the GI sheet.

**5.9.3.3** After stuffing with glass wool padding (**5.9.3.2**), the opening (**5.9.3.1**) is firmly closed by nailing the GI sheet.

**5.9.3.4** Steps **5.9.3.1** to **5.9.3.3** are repeated till the entire roof is insulated from inside.

### 5.10 Barn Door

For both barn types, a wooden door (double shutter type of size 1.85 × 1.00 m that opens outside, shall be erected on the plinth slab at the front (AB side) of the barn. The shutters from inside shall be covered with GI sheet 0.40 mm thick (28 gauge) leaving sufficient gap for filling with insulating material as prescribed in **5.9.3.2** and **5.9.3.3**. The GI sheet covering also provides fire safety.

### 5.11 Observation Windows

There shall be two types of observation windows in each barn:

a) *Leaf observation window (OW)* — Meant for inspecting the leaf during curing; and
b) *Curometer window (CW)* — Use for recording the temperatures inside the barn.

Observation windows for the two barn types are identical.

#### 5.11.1 *Leaf Observation Window*

The leaf observation window (OW) shall be of a single-shutter type that opens outside. The window shall have a wooden frame (0.65 × 0.90 m). The OW shall be fixed in the wall on the BC side of the barn at a height of 3.66 m from the plinth level in both Type A and Type B barns (Fig. 9 and Fig. 10). The shutter from inside shall be covered with GI sheet 0.40 mm thick (28 gauge) leaving sufficient gap for filling with insulating material as prescribed in **5.9.3.2** and **5.9.3.3**.

#### 5.11.2 *Curometer Window*

The curometer window (CW) shall have a wooden frame (0.4 × 0.4 m) with a fixed glass pane and fitted in the wall on side CD (chimney side) at a height of 1.2 m from the plinth level (Fig. 5 and Fig. 6).

**5.11.2.1** The curometer shall be hung roughly in the middle of the barn and in line with the curometer window (CW). A suitable pulley and rope arrangement is provided to pull the curometer to the window for noting the readings of the wet and dry bulb thermometers.

### 5.12 Bottom Ventilators (BV)

The bottom ventilators (BV) for both barn types A and B are exactly similar in design, fabrication and their fitting in the barns. At least two ventilators shall be fitted in each wall of the barn at the plinth level (Fig. 1 and Fig. 2).

**5.12.1** The bottom ventilators (BV) shall be of single-shutter type made of wooden frame (0.61 × 0.305 m). These ventilators are fixed at the plinth level in the walls of the barn, opening outside vertically. Eight bottom ventilators shall be fitted in each barn as shown in Fig. 1 and Fig. 2. The shutters shall be covered from inside with GI sheet 0.40 mm thick (28 gauge) leaving gap for stuffing with insulating material as prescribed in **5.9.3.2** and **5.9.3.3**.

NOTE — The number and size of the ventilators can be suitably adjusted to suit the barn size if different from the barn specification prescribed in **5.3**.

#### 5.12.2 *Shutter-type Top Ventilators*

The shutter-type top ventilators for Type A and Type B barns are similar in all respects except their size (*see* **5.12.2.1** and **5.12.2.2**). A sketch of the shutter-type top ventilator is given in Fig. 11 as an illustration. The shape of the frame (inverted V or U or their variations) can be adopted to suit local conditions.

Each barn shall be fitted with at least one shutter-type top ventilator (*see* Fig. 3, Fig. 4, Fig. 7 and Fig. 8) over the vent in the roof ridge specially provided during the roof construction (**5.9.1** and **5.9.2**). The top ventilator consists of a shutter and a frame to support the shutter. The frame is fabricated from 25 × 25 × 3 mm angle-iron sections and is fitted firmly on the purlins of the roof frame, centring the shutter. The frame is coated with anti-rust paint. The shutter is fabricated from GI sheet 0.55 mm thick (25 gauge) and is sized and shaped to fit over the roof ridge as well as a portion of the roof to close the vent fully. Since, ventilation is required only periodically, the vent has to be opened and closed as needed. To start ventilation, the shutter has to be lifted vertically upwards to a height of at least 0.2 m. For this purpose, the shutter is fitted with two hooks made of mild steel, in its centre at 50-60 cm from its two ends and the cross bar of the frame is fitted with two pulleys in line with the hooks on the shutter. Two pieces of a rope tied to the hooks, are passed through the corresponding overhanging pulley and then tied to a guide rope of sufficient length to reach below the lintel level. The guide rope passes through a 5 cm single-groove pulley at the edge of the roof. The shutter ventilator is operated manually by the use of this rope from the ground level (Fig. 7 and Fig. 8).

#### 5.12.2.1 *Type A barn*

The vent in the roof ridge shall be 0.31 m wide and 2.13 m long and the shutter to cover the vent shall be 0.46 m wide and 2.59 m long (*see* Fig. 3 and Fig. 7).

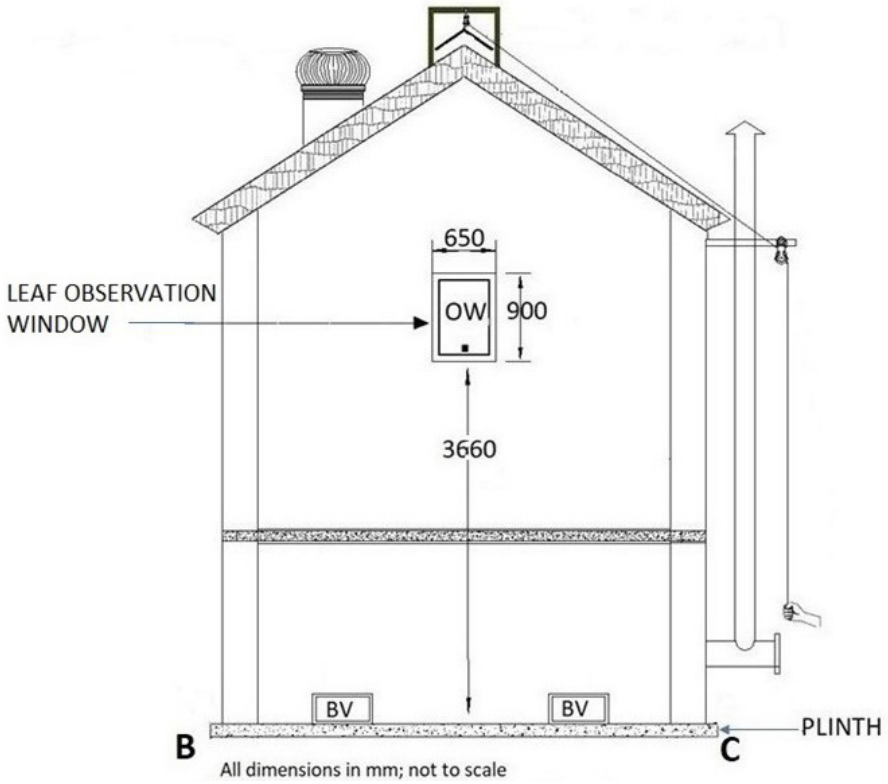



FIG. 9 ELEVATION SIDE BC — BARN TYPE A

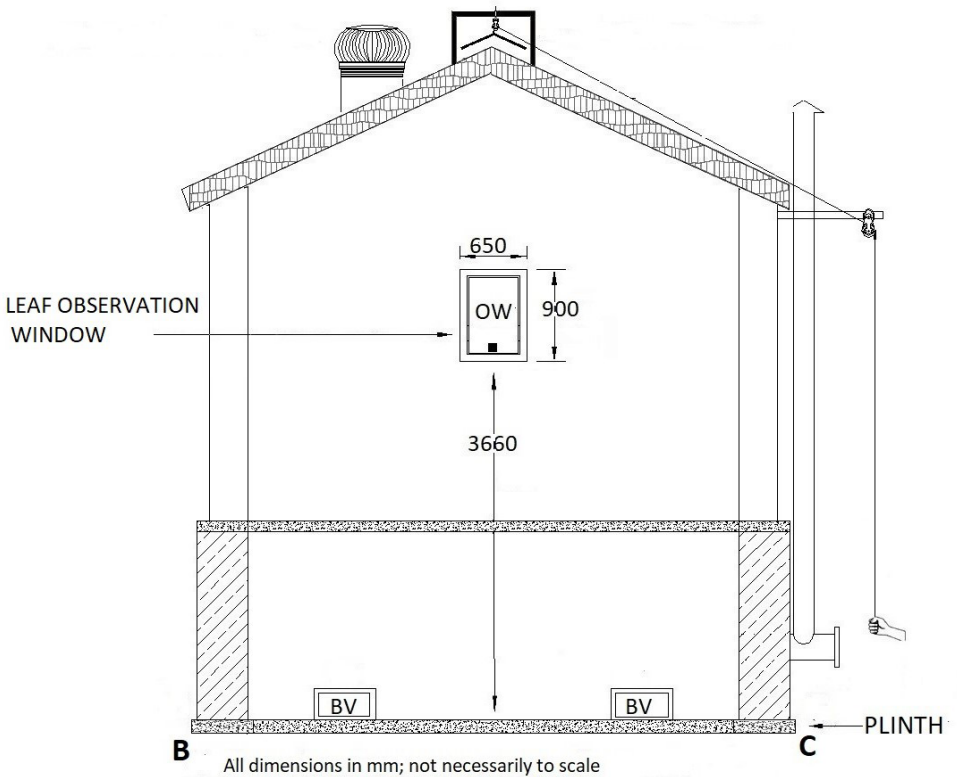



FIG. 10 ELEVATION SIDE BC — BARN TYPE B

**5.12.2.2** *Type B barn*

The vent in the roof ridge shall be 0.31 m wide and 2.53 m long and the shutter to cover the vent shall be 0.46 m wide and 3.08 m long (*see* Fig. 4 and Fig. 8).

**5.12.3** *Turbo Ventilator*

**5.12.3.1** A turbo ventilator of 500 mm throat ring (*see* Fig. 12), pre-fitted with a flaps assembly, shall be installed at the centre of the barn roof on the opposite side of the chimney by following the installation procedure and instructions provided by the supplier.

**5.12.3.2** A special fibre-reinforced plastic (FRP) base is provided by the turbo ventilator suppliers so that the ventilator can be fitted vertically straight on the sloping roofs of the barns. The shape and size of the base will depend upon the roof structure. A sketch (*see* Fig. 13) of the FRP base is given as an illustration.

**5.12.3.3** A flaps assembly consists of two semicircular flaps attached to the two hinges fitted on a rod (*see* Fig. 14). The size of the flaps shall be such that, in the closed condition shown in Fig. 14, the flaps shut the throat opening of the turbo ventilator and stop ventilation. Wires of sufficient length, tied to the two flaps, are passed through the throat of the turbo ventilator and then dropped from the roof to below the lintel level. The wires are used to operate the flaps manually from the ground level.

The assembly is fitted at the opening of the throat of the ventilator in such a way that the flaps open by hanging from the hinges due to gravity when the wires are let loose and close upwards when the wires are pulled tight. The flaps remain mostly closed and are opened only when the ventilation is required.

**5.13 Arrangement of Flues**

**5.13.1** The arrangement of furnace pipe (FP) and flue pipe (FLP) is the same in both A and B type barns (*see* Fig. 1 and Fig. 2). The flue pipes shall be supported by brick pedestals (P) and the height of the flue pipe from the floor shall be 0.31 m. The spacing between the walls and the flue should not be more than 22 cm.

**5.13.2** The flue pipes shall be fabricated from mild steel sheets of minimum 0.81 mm thickness and the diameter of the pipe shall be at least 300 mm.

**5.14 Chimney**

The chimney shall be fabricated from the same material as used for the flue pipes, the diameter shall be 200 mm and the height slightly more than the eave height.

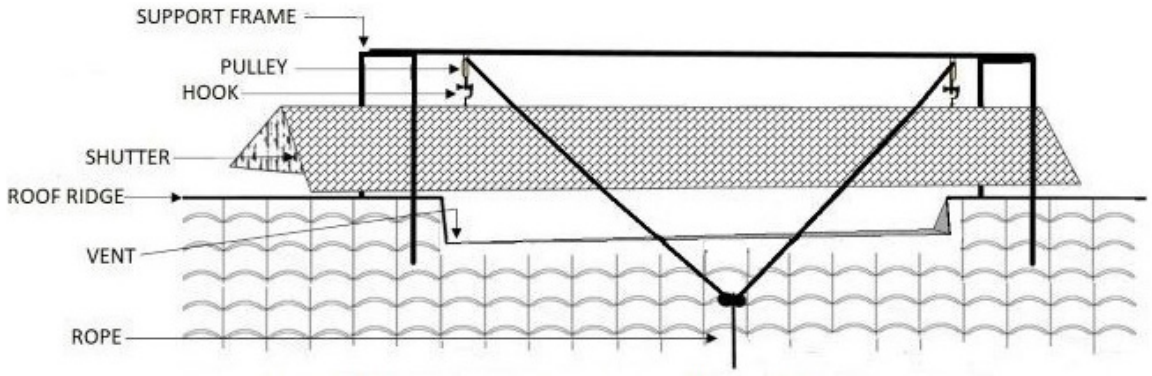



FIG. 11 SHUTTER-TYPE TOP VENTILATOR (SCHEMATIC)

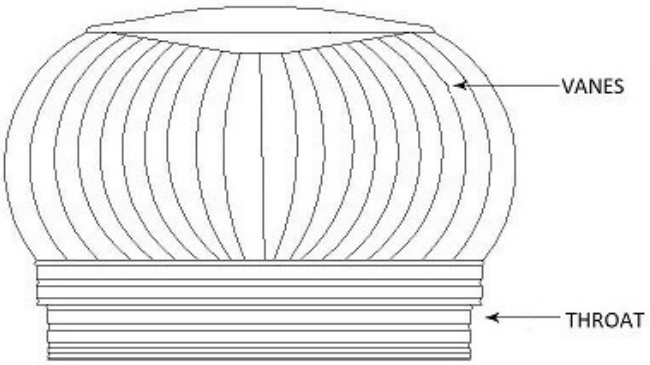



FIG. 12 TURBO VENTILATOR

It shall be fixed at a height of 0.30 m above the level of the furnace (see Fig. 7 and Fig. 8).

**5.15 Tiers**

The total number of tiers will depend upon the barn dimensions, number of horizontal tiers depend up on the barn length and vertical tiers on its gable height. The distance between consecutive horizontal tiers and between consecutive vertical tiers will depend up on the type of barn and the size of the leaf. The tiers shall be wooden poles inserted through the holes in the facing eve-end walls and the holes shall be sealed air-tight. The space between the gable-end wall and its closest tier shall be a minimum of 1 m.

**5.15.1** *Type A Barn*

The barn will have 5 vertical tiers and 4 horizontal tiers. The vertical distance of the bottom tiers from the floor of the barn shall be 1.95 m (*see* Fig. 7) and the other tiers shall be spaced at 0.70 m vertically and 1.2 m horizontally (*see* Fig. 3 and Fig. 7).

**5.15.2** *Type B Barn*

The barn will have 5 vertical tiers and 5 horizontal tiers. The vertical distance of the bottom tier from the floor of the barn shall be 1.95 m (*see* Fig. 8) and the other tiers shall be spaced at 0.75 m vertically and 1.1 m horizontally (*see* Fig. 4 and Fig. 8).

**5.16 Furnace**

**5.16.1** Fuel efficient furnaces suitable for the locally available fuel, including agricultural waste, shall be installed for heating the barns.

**5.16.2** A stainless steel wire mesh (less than 1.25 cm or equivalent mesh) shall be provided over the furnace and the flue pipes at 0.60 m from the floor to prevent fire hazards.

## 6 HEAT SAVING MEASURES

Heat loss through radiation and leaks from the door and windows and tier openings in the walls can be major causes of fuel wastage. Every effort shall be made to prevent heat loss and conserve fuel.

**6.1** The door and the window shutters should be insulated with glass wool or paddy straw by the method prescribed in **5.9.3.2** and **5.9.3.3**.

**6.2** The door, windows and tier holes in the walls are potential source of air leaks. These fixtures should be regularly checked and air leaks, if any, shall be plugged.

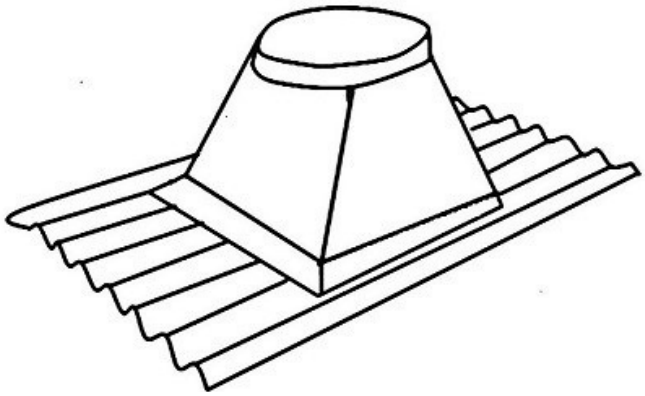


FIG. 13 FRP BASE FOR TURBO VENTILATOR

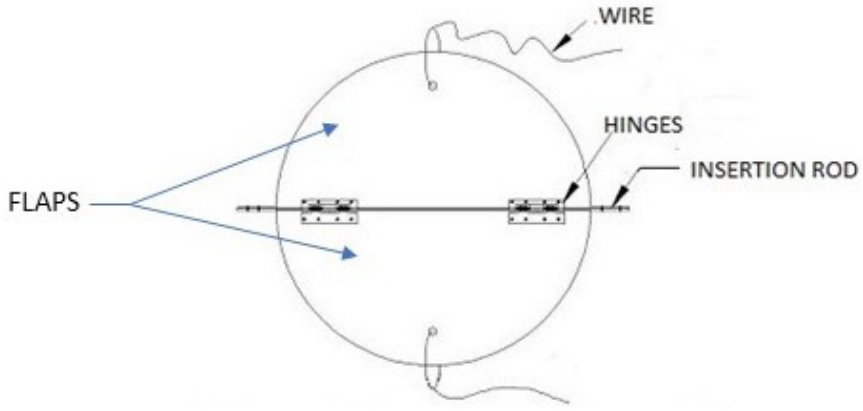



FIG. 14 FLAP ASSEMBLE FOR TURBO VENTILATOR

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## Amendments Issued Since Publication

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